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Design of a Ride Quality Augmentation System for Future Business Jets

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Abstract

Business jets manufacturers normally compete based on options and amenities they offer to comfort their potential passengers and crew. We expect future business jet to have long-range capabilities together with capabilities for short take-off and landing; ability for formation flights and features like bathing. This work concentrates on the latter as we show a well-designed Stability Augmentation System (SAS) could support passengers to take showers while having no harness. Preliminary investigations suggest that potential business jet passengers enjoy being able to take showers in the last 60 minutes of flight; that is before landing. However, the biggest challenge is to develop a SAS that works with the same quality throughout the whole cruising leg of the mission. In this work, the aircraft under investigation is DeBiz-2017 which is designed based on AIAA 2017 design competition rules; and the main contribution of this work is RCS design of it. Dryden turbulence model has been employed to evaluate the aircraft Ride Quality System. Further investigations might be necessary for other classes of turbulence.

Keywords: control system, business jet, ride quality, gust alleviation, Dryden model, phugoid in landing

Introduction

While industry leaders debate the possibilities for fully automated aircraft, the most-recent-generation business jets and the next generation are introducing technologies that set the stage for that possibility. The new aircraft are coming to market wholly integrated, with fly by wire, full authority digital engine control, and more extensive electrification.

Private fly has now been as essential part of the business development strategy for key operator for several years, it is certainly true to say that we are at a stage in the technological revolution of airplane industry where no operator should ignore the marketing possibilities for their business.

So for sure, any airplane with more reliable and more amenities can grab the market. One of these amenities can be the place for the passengers to have some time for their personal grooming. Having a good bathroom condition needs a control system which can make all the acceleration on the person, who is under the shower as minimum as possible that no injury happen to the person and also the minimum ride quality criteria being reached. With the aid of the designed control system in this research, passengers can spend a delicate time in the bathroom of the business jet regardless of the outside gust that threaten the aircraft. The other issue in this research is dealing with microburst in landing phase and make the phugoid mode more stable. With this improved control system which is activates in landing phase, the new coming business jet can experience a safe and comfortable landing. Besides, it is worth to say that, in 2017 AIAA design competition for new coming business jet with the name of DeBiz, we were subjected to a design challenge in design cycle of it. This ride quality augmentation control system has designed for it [1].

Ride Quality System during Cruise

The new coming business jets have an incredible feature which allows passengers to take shower in the last hour of cruise. Since passengers are more likely to take shower as they are closer to airport, we have decided to use this feature in the last hour of cruise. In this case gust alleviation system activates.

A design challenge of DeBiz design cycle is as it gets affected by gust the person who is taking shower would not get injured.
Schematic of this scenario is shown in "Figure 1":

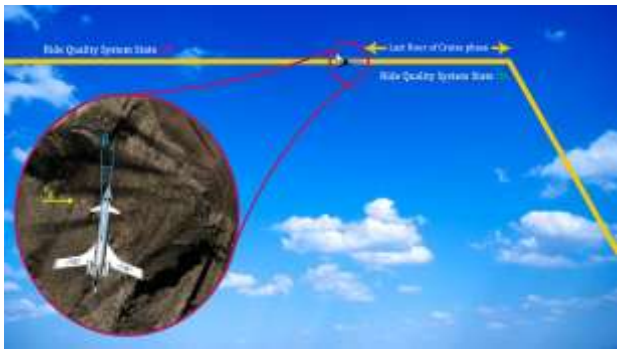

Figure 1. Business jet cruise in presence of gust

For this purpose, the ride quality criteria are used to ensure that the controlled aircraft will provide passenger comfort to an acceptable level. Ride quality specifications express vertical acceleration should be limited to ±0.05